

红腹锦鸡和白腹锦鸡卵壳的超微结构

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摘要 本文报道了锦鸡属——白腹锦鸡和红腹锦鸡卵壳的气孔、外壳膜、锥体层、木栅层的超微结构。并对两者的卵壳进行了比较。

关键词: 红腹锦鸡, 白腹锦鸡, 卵壳, 超微结构

锦鸡属鸟类, 共两种, 即白腹锦鸡和红腹锦鸡, 均属于国家 I 级保护动物。主要产于我国中部和西部山地, 国外见于缅甸东北部。近年来, 我国鸟类学工作者对白腹锦鸡(杨炯鑫等, 1981; 韩联宪等, 1989) 和红腹锦鸡(吴至康等, 1982; 庞秉璋, 1984) 的生态和分类(Liu Rusun 等, 1989) 以及生化(刘如笋, 1988等) 方面均有研究。

本文就卵壳超微结构的观察和比较结果进行了报道, 为研究鸟类分类和演化中的亲缘关系提供一些基础资料。

材 料 和 方 法

红腹锦鸡和白腹锦鸡的卵壳均由北京动物园提供。两种卵的外形极为近似, 呈椭圆形, 表面光滑无斑, 均呈淡黄褐色。

将两种卵壳的同一部位取下一小块, 充分洗净, 放入用0.2M磷酸缓冲液pH 7.4配制5%戊二醛固定4小时, 再用此缓冲液冲洗3次, 每次20分钟, 然后用乙醇梯度脱水, 自然干燥后, 将样品置入HUS—5GB真空镀膜仪喷金, 以日立H—3010扫描电子显微镜观察。

结 果 与 讨 论

壳表有一种白垩有机覆盖物, 或一种香脂类为主的无机覆盖物, 是产卵期间输卵管上的腺细胞分泌在卵壳上的润滑剂和分泌物。但不影响气体的通透并可防止卵中水份的

丧失。香脂类覆盖物还能使产于潮湿、泥泞的锦鸡露天巢中的卵保持洁净。

红腹锦鸡和白腹锦鸡的卵壳表面都有龟裂状纹(图版 I: 1、5)。但两者有明显的差别。红腹锦鸡龟纹细,数量少,纹间间断,而白腹锦鸡的龟纹较粗,数量较多,并多有相互连接者。

壳膜由多醣蛋白质组成,分内外两层。在扫描电镜下,可看到呈稠密的纤维簇。膜纤维间的空隙和纤维的粗细直接和卵质有关。卵钝端在孵化期膜被分开,含有大量气体,这些膜按不均等的间隔松散地融合在一起。除了开始阶段外,当膜潮湿时大部分孵化期可让气体自由扩散。在卵壳形成过程中,膜起着保护卵的内含物作用,并将内含物锚在钙晶体形成的芽晶体上。

两种锦鸡的外壳膜由蛋白质纤维交错编织而成网状结构。红腹锦鸡的外壳膜纤维网成球状,球与球之间有明显的间隙(图版 I: 2);白腹锦鸡的外壳膜纤维则杂乱无章,错综复杂地交织在一起,且非常致密(图版 I: 6)。

典型卵壳的结构可分为外壳膜、乳头结、基帽、锥体层和木栅层(卢汰春,1990)。外壳膜(outer shell membrane)有内、外两层,包在卵的内含物外面并将它固定在卵壳上;乳头结(mamillary core)是固定在膜上的有机隆起,它被包围在晶体钙中,需经特殊处理方可看见;基帽(basal cap)是由晶体钙向下突起并穿入到膜纤维中;锥体层(cone layer)是晶体钙的垂直突起;木栅层(palisade layer)由锥形体融合而成。木栅层是一种碳酸钙的晶体,通常卵壳含有98%的结晶钙,在少数几种鸟类的卵壳和卵壳覆盖物中已检出微量霏石(aragonite)和香脂类物质(vaterite),是一种碳酸的替代形式。卵壳的其他成份包括少量浓缩的镁、磷和散布在整个晶体层的有机物质,一种蛋白——粘多醣的化合物,它的功能尚不清楚,可能是晶体钙内部的支持结构,以加强卵的机械支撑作用;表皮位于卵壳最外层,为直接与外界相接触的部分。

卵壳辐射状断面(radially fractured eggshell)应能清晰地看到上述各部分的结构特征,但由于诸多原因,如断面不完整,卵壳破损,某些结构(气道、乳头结等)未经特殊处理及其他技术问题,难以在一个断面上显示出各部分结构特徵。

红腹锦鸡(图版 I: 3)和白腹锦鸡(图版 I: 7)卵壳辐射状断面:红腹锦鸡卵壳的表皮(图版 I: 3A)、气孔口(图版 I: 3B)、木栅层(图版 I: 3C)、锥体层(图版 I: 3D)及壳膜(图版 I: 3E);白腹锦鸡卵壳的表皮(图版 I: 7A)、气孔口(图版 I: 7B)、木栅层(图版 I: 7C)、锥体层(图版 I: 7D)和壳膜(图版 I: 7E)。

两种锦鸡卵壳相似点与区别特征:表皮均精密细致,颗粒状,两者均为帽盖气孔。但红腹锦鸡卵壳表皮的颗粒较粗,而白腹锦鸡卵壳表皮的颗粒细而密;红腹锦鸡卵壳的气孔口较白腹锦鸡大;红腹锦鸡的木栅层似长棱形而白腹锦鸡近似棱形。

红腹锦鸡的气孔口(图版 I: 4)呈现出椭圆形,比较大。而白腹锦鸡的气孔口(图版 I: 8)类似枫叶状,较小。此外,从上述两种气孔口尚可看到2个小孔,说明它们的气道是分叉的。

两种锦鸡卵壳的锥形体均不甚清楚。内膜和外膜纤维比较稠密,但内外膜的界限不清楚。

红腹锦鸡和白腹锦鸡同属于锦鸡属, 从卵壳的超微结构可以看出它们之间有相似点, 如表皮呈颗粒状, 具龟裂状纹; 外壳膜纤维交错编织成网状, 属盖帽气孔, 气道有分枝等。但它们又是不同的两个种, 这在卵壳的超微结构中可以看出它们之间的明显差异: 红腹锦鸡卵壳的表皮颗粒较粗, 裂状纹细, 数量亦少, 纹与纹之间有间断; 外壳膜纤维网成球状, 球与球之间有明显间隙, 气孔较大, 气孔口呈椭圆形, 木栅层似长棱形。而白腹锦鸡裂纹数量较多且粗, 互相连在一起; 外壳纤维错综复地交织在一起, 气孔口较小, 呈枫树叶形, 木栅层似棱形。二者卵壳超微结构上的差异为锦鸡属的分类提供了依据。

图 版 说 明

1. 红腹锦鸡的卵壳表皮 (the cuticle of eggshell of *Chrysolophus pictus*) $\times 1500$
2. 红腹锦鸡的外壳膜 (the outer eggshell membrane of *Chrysolophus pictus*) $\times 500$
3. 红腹锦鸡的辐射断面 (the radially fractured eggshell of *Chrysolophus pictus*) $\times 120$
4. 红腹锦鸡的气孔口 (the pore mouth of *Chrysolophus pictus*) $\times 2300$
5. 白腹锦鸡的卵壳表面 (the cuticle of eggshell of *Chrysolophus amherstiae*) $\times 1500$
6. 白腹锦鸡的外壳膜 (the outer eggshell membrane of *Chrysolophus amherstiae*) $\times 500$
7. 白腹锦鸡的辐射断面 (the radially fractured eggshell of *Chrysolophus amherstiae*) $\times 120$
8. 白腹锦鸡的气孔口 (the pore mouth of *Chrysolophus amherstiae*) $\times 2200$

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THE ULTRASTRUCTURE OF EGGSHELLS OF *Chrysolophus pictus* AND *Chrysolophus amherstiae*

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Chrysolophus, an endemic genus of Chinese pheasants, has two species. They are *C. pictus* and *C. amherstiae*, considered as 2nd category of animals for protection under China's game laws. They are mainly distributing in the central and western parts of China. The present paper deals with our studies of the ultrastructural eggshell of the two species. There has been so far no

works dealing with the ultrastructural eggshell of both *C. pictus* and *C. amherstiae* in China or the rest of the world.

The microstructures of avian eggshell are composed chiefly of cuticle, outer shell membrane, mamillary core, cone layer, palisade layer, basal cap, pore channel and pore mouth etc. The results of our observation of the above ultrastructural eggshell of both *C. pictus* and *C. amherstiae* may be summarized as follows.

1. Cuticle of eggshell of *Chrysolophus* is covered with a thin organic cuticle, a chalky organic cover, or an inorganic cover composed primarily of vaterite. The true cuticle is principally composed of protein, fat and polysaccharides of sugars.

The cuticles of the eggshell of both *C. pictus* and *C. amherstiae* are alike, while those two species are smoother and have granules and the appearance of cuticles resembles tortoise-shell streak. There are some differences to be seen in the cuticle of the two species. The tortoise-shell-like of *C. pictus* is slender and have more numbers than that of *C. amherstiae*.

2. The outer eggshell membranes

The outer eggshell membranes can usually be divided into the inside of the inner membrane and the outside of the outer membrane. Both membranes adhere to each other except at the broad pole of the egg, where an intervening air-space is formed. Under the scanning electron microscopy the membrane appears as profuse mat fibres, which consist of variable proteins.

There are obvious differences in the forms of the fibres of eggshell membrane among the two species. Under scanning electron microscopy the fibres of *C. pictus* likes shape of balls and that of *C. amherstiae* likes as a very complicated. There are quite a lot of big gaps between them.

In the radially fractured eggshell of both *C. pictus* and *C. amherstiae* the cuticle, outer eggshell membrane, cone layer, palisade layer, basal cap etc. may be seen. In the radially fractured eggshell the inside of the inner membrane and the outside of the outer membrane can be indistinctly seen.

3. The pore mouth

The eggshell surface also shows something of a sphere. Large openings are called "pore mouth". The pore mouth leads to the connection between the outside environment and the space between the cones. The pore mouths of the eggshell of *C. pictus* are quite round. However, the pore mouths of *C. amherstiae* are like a leaf of Chinese sweet gum (*Liquidambar taiwantana*).

Key words: Golden pheasant, Chinese coquerel pheasant, Eggshell, Ultrastructure

图版 I

